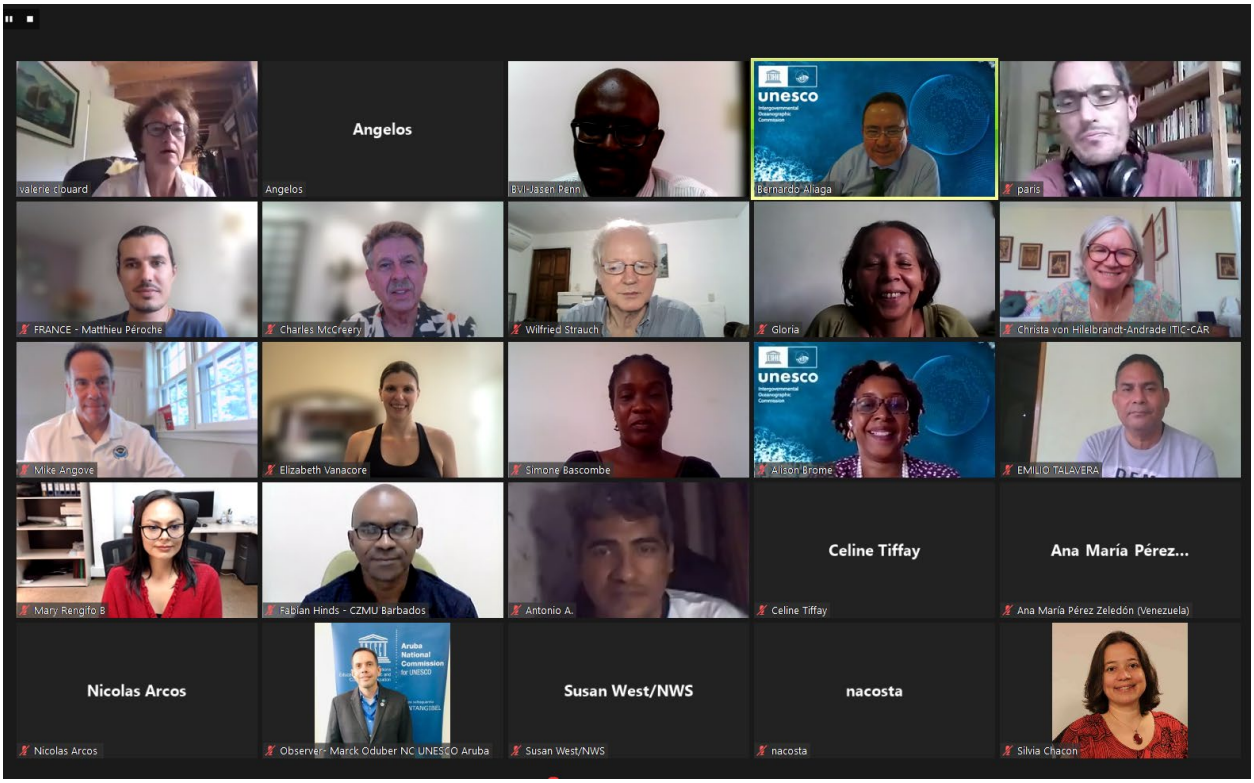
# REPORT OF THE ICG/CARIBE-EWS Meeting of Officers

*Tuesday 7 and Thursday 9 June 2022*

Online




## *1 Welcome and Opening*

Dr Silvia Chacon Barrantes, Chairperson of the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS), and Mr Jasen Penn, Vice-Chair of the ICG/CARIBE-EWS, conducted the meeting. Mr Jasen Penn warmly welcomed the participants and thanked them for their continued work in 2021 and 2022.

Mr Bernardo Aliaga, Technical Secretary of the ICG/CARIBE-EWS, provided a report on key relevant decisions from the Working Group on Tsunamis and Other Hazards (TOWS-WG) Fifteenth Session in February 2022. Regarding substantive items, he highlighted the decisions to 1) Modify the Terms of Reference of TOWS-WG to be inclusive of discussion on new developments, including the UN Ocean Decade, 2) Request to the Intergovernmental Oceanographic Commission (IOC) 55$^{th}$ session of the Executive Council to endorse the Tsunami Ready Recognition Programme (TRRP), and 3) Establish the Tsunami Ready Coalition.

Mr Aliaga also highlighted decisions relating to operational matters, noting the decision to modify the Pacific Tsunami Warning and Mitigation System (PTWS) Earthquake Source Zone (ESZ) to

include the southern Atlantic region (currently under the CARIBE-EWS) ESZ, based on recent events in the region which impacted the PTWS area. Mr Aliaga also noted that the TOWS-WG is inviting Member States with coastlines along the southern Atlantic—specifically West Africa and the Atlantic coast of South America—to consider an expansion of the IOC's Global Tsunami Warning and Mitigation System to cover this region.

Finally, Mr Aliaga highlighted key decisions from TOWS-WG regarding instructions to ICGs, including to encourage sea-level network operators to undertake regular and routine calibration of their sea-level monitoring instrumentation, to routinely monitor the status of seismic and sea-level related observing networks to identify and better help rectify gaps in coverage, that Tsunami Service Providers (TSPs) and National Tsunami Warning Centres (NTWCs) identify all coastal areas or near-shore fault that could generate large earthquakes and submarine landslides, the IOC Tsunami Programme Secretariat to advise countries that are currently in the process of implementing Tsunami Ready to now follow Manuals and Guides 74 *Standard guidelines for the Tsunami Ready Recognition Programme*, and to recognize the advisory role of Tsunami Information Centres (TICs) in facilitating the UNESCO/IOC TRRP Finally, Mr Aliaga shared that the TOWS-WG set up the a*d hoc* Task Teams (TTs) on Meteo-tsunamis and on Tsunamis Generated by Volcanos; the latter will build on work undertaken in the CARIBE-EWS region.

The Chair, Dr Silvia Chacon, gave her report, drawing attention to the renewal of Tsunami Ready recognition for St. Kitts and Nevis in February 2022. Several updates were made including to maps, signs and Standard Operating Procedures (SOPs). St. Kitts and Nevis also participated in CARIBE WAVE exercises from 2016 to 2019 and in 2021. Dr Chacon commended St. Kitts and Nevis for their innovative and creative approach to tsunami awareness, outreach and capacity-building through murals and animated videos.

Dr Chacon also reported on the Caribbean Regional Workshop on Measuring Effectiveness of Multi Hazard Early Warning Systems held in Port of Spain, Trinidad and Tobago, 10-11 May 2022. At this time, multi-hazard early warning systems (MHEWS) indicators were developed based on the Sendai Framework for Disaster Risk Reduction (SFDRR) indicators and under four pillars: risk knowledge, monitoring and warning services, dissemination and communication, and response capabilities. She noted that although these indicators are very comprehensive and useful for assessing the effectiveness of MHEWS, they are sometimes challenging to measure. Nonetheless, they provide a helpful estimation of effectiveness and can be refined over time.

## *2 Organisation of the session*

Mr Jasen Penn presented the agenda and technical arrangements for the meeting. The Group accepted the agenda.

## *3 Report of TSPs and TICs intersessional activities*

### *3.1 Report of the Caribbean Tsunami Information Center (CTIC)*

Ms Alison Brome, Programme Officer for Coastal Hazards at the Caribbean Tsunami Information Centre (CTIC), reported on this agenda item, highlighting key CTIC activities in the period 2021-2022, updates on ICG/CARIBE-EWS-XV recommendations, and select UNESCO/IOC Tsunami Unit and TIC activities.

Ms Brome gave a status update on Tsunami Ready recognized communities in the CARIBE-EWS, noting that the British Virgin Islands and St. Kitts and Nevis renewed their recognitions, with renewal of Anguilla pending. In addition, Ms Brome drew attention to new communities recognized Tsunami Ready, including Old Harbour Bay, St. Catherina (Jamaica) that achieved recognition in January 2022.

CTIC is also involved in several upcoming Tsunami Ready community recognitions including for Puerto Plata and Sabana Grande de Palenque (Dominican Republic) in September 2022 and St. George (St. Vincent and the Grenadines). Through funding from Australian Aid (AusAid), Grenada is working towards Tsunami Ready recognition with projected completion by December 2023. In addition, the project "Towards a Safer Ocean in the Caribbean through Tsunami Ready Communities" was recently launched based on funding received from the Norwegian Agency for Development Cooperation (NORAD) with the aim to support new Tsunami Ready communities in Barbados, Jamaica, and Trinidad and Tobago, building on existing structures and expertise. Lastly, another Tsunami Ready project lead by the International Tsunami Information Center Caribbean Office (ITIC-CAR) and United States Agency for International Development (USAID) is under way for communities in St. Matthias to Rendevous, Christ Church, Barbados, as well as Dominica, and St. Lucia with projected completion within 12 to 18 months.

Ms Brome also reported on other CTIC intersessional activities, including support of ICG/CARIBE-EWS WG4 meetings and review and development of documents and resources; updates to the CTIC website with completion and transfer to the International Oceanographic Data and Information Exchange (IODE) scheduled by 30 June 2022; and support to TT Tsunami Ready on meetings, review and development of documents and resources, and review, update and digitizing of Tsunami Ready evaluation surveys. In addition, CTIC played a role in CARIBE WAVE 2022 by supporting the review, registration, and promotion of the Exercise Handbook, as well as supporting the running of related webinars, the exercise, and the evaluation process. With regards to the UN Ocean Decade, CTIC supported efforts through document review, meetings, presentations, and project development, including for example the "Safe Ocean" WG meetings and the Safe Ocean Laboratory on 7 April 2022. The latter had 198 participants and showcased Tsunami Ready communities across all ocean basins, notably underlining the establishment of a Blue Line for Jamaica, the importance of multi-annual tsunami exercises (Costa Rica) and sharing experiences on response to volcanic hazards. The Ocean Laboratory event also included a workshop on non-seismic tsunami sources.

For World Tsunami Awareness Day (WTAD) 2021 and 2022, CTIC supported the creation of videos. CTIC has also been working on themes of Ocean Literacy, notably disseminating PAE materials to Member States and supporting the development of Ocean Teacher Global Academy (OTGA) modules on Tsunami Awareness and Tsunami Ready.

Mr Brome reported that CTIC is also engaging partners and Member States, including through support to the Caribbean Regional Workshop on Measuring Effectiveness of Early Warning Systems held in Trinidad and Tobago in May 2022. This workshop facilitated deeper cooperation between ICG/CARIBE-EWS and UN Office for Disaster Risk Reduction (UNDRR) regarding the Regional Early Warning System Consortium (REWSC) to support Member State preparedness and resilience. CTIC also has several ongoing partnership agreements and technical collaborations with regional partners, including ITIC-CAR, Caribbean Disaster Emergency Management Agency (CDEMA), Seismic Research Centre (SRC), and the Coordination Centre for the Prevention of Natural Disasters in Central America (CEPREDENAC). CTIC is notably working on reviewing draft framework agreements initiated with CDEMA.

CTIC also plays a role in resource mobilization and strategic development through support of UNESCO/IOC in project and strategic developments, including a potential upcoming opportunity with the Japan International Cooperation Agency (JICA).

Ms Brome reported on follow-up actions regarding ICG/CARIBE-EWS-XV recommendations. These include collaboration with Member States and TT Tsunami Ready to work towards increased Tsunami Ready communities, collaboration to mobilize funding and in-kind support, coordination with WGs and TTs about actions and outputs of CARIBE WAVE 21, and development of public awareness materials for local tsunami events.

Ms Brome noted key considerations and challenges for CTIC in the intersessional period, underlining financial and human resource constraints and implications for achievements, maximization of opportunities for enhanced technical collaboration and resource mobilization, COVID-19 pandemic and impact on priorities, limited avenues for distribution of hard copy educational and outreach materials, and the need for sustained preparedness activities for tsunamis, for deepening existing mechanisms and for exploration of new opportunities to facilitate the integration of impacts and risks associated with other coastal hazards within CARIBE-EWS.

Ms Brome also provided a brief report on the Third Multi-Hazard Early Warning System (MHEWS-III) Conference in Bali, Indonesia, in May 2022, highlighting key outputs and outcomes of the Tsunami Unit including support to publishing of Words into Action Guide on MHEWS, contributions to finalizing the MHEWS-III Conference Report, co-authoring of a paper on Innovation: Next Generation of EWS, and preparing and publishing news articles. The Seventh Global Platform for Disaster Risk Reduction (GPDRR-7) was also held in Bali, Indonesia, in May 2022. Key outcomes included taking stock of SFDRR implementation, recommend actions for policy makers, highlight good practice and raise awareness; outcomes to contribute to the inter-governmental midterm review of the SFDRR scheduled for 2023; and launched two UNESCO/IOC Tsunami Ready communication tools – Tsunami Ready boardgame and the 14 animation short videos of Tsunami Ready community.

Ms Christa von Hillebrandt-Andrade commented on the meaning of the Ocean Decade Tsunami Programme (ODTP) target to have “100 percent at-risk communities recognized Tsunami Ready”, noting that through CARIBE WAVE exercises, ITIC-CAR requests countries to indicate their target communities. This can be used a useful baseline for definition which communities are target Tsunami Ready communities. She also noted that that ITIC-CAR is interested in using GIS approaches such as the Blue Line for other initiatives in the region.

Mr Bernardo Aliaga, Technical Secretary, highlighted several upcoming opportunities for Tsunami Ready, including potentially JICA. In this regard, it would be helpful for CTIC to communicate with Member States to identify interested Member States. In addition, GOAL Haiti has reached out and is interested in developing Tsunami Ready communities in Haiti.

### *3.2 Tsunami Services Provider Report (PTWC)*

Dr Charles “Chip” McCreery, Director of the Pacific Tsunami Warning Centre (PTWC), presented the report. He began with an overview of the seismic sensing network monitored by PTWC in the CARIBE-EWS region, specifically identifying those stations which report in real-time. He also reported on the sea-level network in the region, drawing attention to coverage gaps in the far western Caribbean

region as well as continued challenges to the overall Deep-ocean Assessment and Reporting of Tsunami (DART) gauge network, including due to operational issues and servicing needs.

Next, Dr McCreery presented on significant tsunamigenic events, noted the 11 related threat messages during the past intersessional period, and reviewed of the key performance indicators for each event provided. He noted some anomalies, including regarding elapsed time with events in the South Sandwich Islands and mid-Atlantic Ridge. In addition, the magnitudes of events in the South Sandwich Islands also proved challenging.

Dr McCreery gave a review of the three most notable events of the inter-sessional period. The South Sandwich Islands event was a multiple event with the largest earthquake having a magnitude of Mw=8.1. Because of the dearth of sea level gauges in the region (only one in South Georgia Island, United Kingdom), the magnitude of the events was time-consuming to understand. Wave amplitudes greater than 0.6m were recorded at South Georgia Island, in Argentina, and in South Africa. The tsunami was also widely recorded in the Pacific and Indian Oceans. A key challenge of the event was the lack of tsunami alerting system for the southern Atlantic. In response, the ICG/PTWS has agreed to include this source region in its ESZ and the TOWS-WG recommends exploring the expansion of the tsunami warning system coverage to the southern Atlantic. Dr McCreery noted that although the southern Atlantic region does not present a large threat to the CARIBE-EWS region, he suggests maintaining the area within the CARIBEW-EWS too. He also suggested that the ICG/CARIBE-EWS region could be expanded to include the southern Atlantic region.

The second notable event was the Haiti earthquake and tsunami on 14 August 2021. The initial Information Statement for Mw=7.0 was upgraded after 50 minutes to a Threat Message for Mw=7.2. The earthquake epicenter was on the narrow Tiburon Peninsula which meant needing to check for tsunami waves on both sides of the peninsula. Overall, the tsunami waves recorded in Haiti and Mexico were relatively small (< 10 cm).

The final notable event was the Hunga Tonga Hunga Ha`apai (HTHH) volcano eruption and tsunami on 15 January 2022. Tsunami runups in Tonga were over 10 meters with tsunami waves generated and observed in all the world's ocean basins by the atmospheric disturbance. Regarding features of the event, Dr McCreery highlighted the role of atmospheric pressure, and specifically coupling that occurred on the eastern side of the Tonga trench, thereby sending more pressure to the western Pacific. Analysis of the event proved complex and challenging, though was aided by previous work on volcano-source tsunamis in the CARIBE-EWS region. Indeed, volcanic activity of La Soufrière in the Caribbean resulted in placement of triggers on nearby sea-level gauges. Due to minor volcanic activity of the HTHH volcano in the days preceding the eruption, PTWC staff had placed a trigger on the nearby Nuku'alofa gauge in Tonga. As such, PTWC was notified about the eruption about 15 minutes following the event. As such, the Tonga tsunami event demonstrated that this method of "triggers" is useful for warning coastlines which are further away.

Regarding operational response to the HTHH volcano eruption and tsunami, Dr McCreery noted that although the tsunami was detected quickly, no automatic threat area or Pacific forecast was issued since there was no earthquake source and therefore no earthquake parameters. One potential solution would have been to use fake earthquake parameters to generate PTWS text messages and threat areas and manually modify messages for the volcano source. However, dissemination would have been problematic due to the website expecting earthquake parameters. In the CARIBEW-EWS region,

information statements were issued when tsunami waves were observed there from atmospheric pressure waves. Since the event, the PTWC has modified PTWS message codes to handle any future HTHH tsunami, where forecast will be based on scaled 15 January 2022 gauge amplitudes. Dr McCreery suggested a similar approach could be taken in the CARIBE-EWS region, whereby different scenarios of tsunamis from volcanic eruptions could be modelled then scaled according to the nearest readings.

Dr McCreery closed with a brief updated on operational issues of the PTWC during the intersessional period, noting a few infections of staff by COVID-19 but no operational interruptions nor significant PTWC outages.

Ms Christa von Hillebrandt-Andrade enquired whether PTWC had considered the use of Raspberry Shake seismometers (C-type sensors) to fill knowledge-gaps in areas where there is a scarcity of stations. She suggested integrating these types of sensors as data for PTWC operations.

Mr Raphaël Paris recalled that the HTHH event created low-frequency sound waves (i.e. infrasound). For future HTHH events, he suggested building a link between tsunami centres and infrasound networks as data on infrasound would enable calculation of the energy of explosion, and as such support information about tsunami generation. Dr McCreery agreed this would provide useful data and should be pursued.

### *3.3 Report of the Central America Tsunami Advisory Centre (CATAC)*

Dr Wilfried Strauch began by recalling that the creation of CATAC was accepted by ICG/PTWS, ICG/CARIBE-EWS and the IOC Assembly in 2015. In 2019, the CATAC reinforcement project was completed with Japan and ICG/PTWS and ICG/CARIBE-EWS accepted experimental operation of CATAC.

CATAC relies on 300 seismic stations in Central America and 200 global seismic stations via Incorporated Research Institutions for Seismology (IRIS). There are two watchstander that work 24/7, from a group of 16 watchstanders. Seismological processing is conducted with SeisComP PRO. Tsunami evaluation is done with a database and using SeisComP TOAST for real-time simulation. CATAC sends an initial alert message within two minutes of an earthquake. A tsunami parameter message is disseminated less than 10 minutes after the earthquake. These messages are addressed to 11 monitoring/scientific institutions, NTWCs, nine civil protection agencies and one regional coordinating body (CEPREDENAC).

Dr Strauch indicated the CATAC area of service and area of monitoring. He identified the location of seismic stations in and around Central America used by CATAC, noting insufficiencies in Honduras, Panama, and Costa Rica. Indeed, in Honduras only three of the 14 stations are in operation due to COVID-19, only ten of the 22 stations of the Universidad de Costa Rica (UCR) in Costa Rica are functional, and Panama only has one station.

A project was launched in 2021 to establish new seismic stations in Nicaragua, El Salvador, Costa Rica and Guatemala. New accelerographs are being installed with 25 in Nicaragua, 25 in El Salvador, 17 in Guatemala, and four in Costa Rica. This will enable reduction of the time needed for detecting and locating earthquakes, improved quality of results, the ability to calculate very fast Moment Tensor (and magnitude) of strong earthquakes with local stations (not saturated), and enable the creation of Shakemaps and seismic impact recording in major installations.

Dr Strauch next recalled the capacity requirements for TSPs, noting that CATAC fulfills the following requirements:

- Access to real-time data sources and capability to produce standardized seismic/sea level parameters,
- Appropriate historical database of earthquakes and tsunamis,
- Maintain or have access to benchmark, pre-calculated numerical model scenarios,
- Revise advisories in light of additional seismic and sea level data,
- Provide timely and effective tsunami advisories to respective NTWCs/tsunami warning focal points (TWFPs) – in Central America,
- Adequately trained and experienced staff, utilities, and resources to operate functionally 24 hours per day, seven days per week (24/7),
- Adequate infrastructure and back-up facilities to continue operating during power cuts and national emergencies such as all critical equipment on 30-minutes UPS, generator or alternative power backup (with one day of back-up capability), all critical equipment operating in duplicate and all critical communications circuits with backup.

With regards to the requirement for dissemination of tsunami forecast information freely and timely to NTWCs/TWFPs on the Global Telecommunication System (GTS) and Internet and all other possible means of communication, Dr Strauch noted that the GTS is still in development and not yet used. Regarding the requirement to provide products in globally standard formats, CATAC is currently disseminating products in simplified regional formats in Spanish, as this is considered more understandable, especially for civil protection agencies. Finally, relating to the requirement for staff to be able to communicate in English, Dr Strauch reported that this is fulfilled with 16 of the 19 staff being fluent in English.

Dr Strauch next reported on CATAC fulfillment of TSP key performance indicators (KPIs), noting that CATAC satisfies all those for earthquake and threat assessment. He particularly highlighted that the required ten-minute elapsed time of the first earthquake bulletin for the TSP area of service (when no coordination is required between TSPs) is performed by CATAC within two minutes. For KPIs pertaining to the TSP functional status, Dr Strauch reported that CATAC satisfies all requirements.

Dr Strauch presented the personnel employed by CATAC. He also noted appreciation cooperation with Central American scientific bodies, including the Instituto Nicaraguense de Estudios Territoriales (INETER); the Ministry of Environment and Natural Resources (MARN) of El Salvador) and the General Directorate of the Environmental Observatory (MARN-DGOA); the Sismología, Vulcanología, Meteorología e Hidrología de Guatemala (INSIVUMEH); the Honduras Comisión Permanente de Emergencias (COPECO) and the Universidad Nacional Autónoma de Honduras (UNAH); the Sistema Nacional de Monitoreo de Tsunamis (SINAMOT) in Costa Rica, the Observatorio Vulcanológico y Sismológico de Costa Rica (OVSICORI), and UCR; and the Panama Institute of Geosciences of the University of Panama (IGC-UPA), Panama Canal, and Ángel Rodríguez. He highlighted that the purpose of CATAC is notably to support national institutions in their national tsunami warning.

The main systems used by CATAC are SeisComP for automatic seismic processing, interactive seismic processing, calculation of the Momentum Tensor from which magnitude is derived and sending seismological and tsunami messages (on seismological basis). There is also a tsunami database with pre-

calculated solutions. Finally, TOAST is used for numerical tsunami simulation; sending of simulation product messages, arrival times and amplitudes; and processing of tide gauge records.

Dr Strauch next set out the tsunamigenic potential adopted by CATAC, noting that it was identical to other PTWS TSPs based on seismological parameters. He also presented the criteria for different types of newsletters including seismological information, tsunami information, and tsunami hazard messages. Dr Strauch briefly showed maps of seismic catalogues, tsunami source descriptions, and based on historical tsunami databases.

Dr Strauch next presented a detailed timeline of the creation of CATAC during its pilot phase (2019-2021). During this time, only seismological messages were routinely sent. Tsunami advisory was conducted in a less formal manner via social media communications with alert recipients in the region immediately after the earthquake. In the experimental phase, CATAC achieved several advances, including doubling of the 24/7 shift staff, employing two people per shift, and staff training.

The accuracy and speed of earthquake and tsunami processing in general was improved. Experience was gained with the processing of strong earthquakes that occurred in the region, including five earthquakes with magnitudes greater than Mw=7, eight earthquakes with between Mw=6.5 and Mw=7, and a large number of earthquakes with less than Mw=6.5. Areas have been identified where local tsunamis can impact in less than ten minutes after the earthquake or tsunami generation. Thus, CATAC was dedicated to accelerating the processing of earthquakes and tsunamis. To reduce the processing time and improve the reliability of the products, a series of concrete measures were taken, including greatly densifying the seismic networks in Nicaragua, El Salvador, and Guatemala through the Early Warning in Nicaragua and Central America (EWARNICA) project with Switzerland, while improving the accuracy of earthquake locations. With the CATAC earthquake early warning methods, CATAC obtains a first location and magnitude of the earthquakes occurring in Central America within a few seconds after the start of the event and also accelerated the calculations of the Moment Tensor and the Mw magnitude. CATAC finalized the development of its tsunami database, which yields tsunami parameters within a few seconds after establishing earthquake parameters.

Moment Tensor calculation was optimized (with the SCAUTOMT and SCMTV modules of SeisComP), allowing the use of data from accelerographic stations that are not saturated by strong shaking near the epicenter. Results are provided rapidly, with focal parameters of the earthquake and magnitude provided within less than ten minutes, which accelerates the tsunami simulation in real-time and the generation of tsunami products. CATAC also optimized the configuration of the TOAST module for tsunami simulation in its SeisComP system.

CATAC also worked to improve the rapid dissemination of products in Nicaragua and other Central American countries. It cooperated with various foreign and national entities to develop and introduce methods for mass dissemination of earthquake and tsunami warning messages. In Nicaragua, the dissemination of messages via digital television has started. Through the EWARNICA project, CATAC also promoted the application of this method in other countries of the region in the coming years.

In Nicaragua, 40 additional sirens were installed in communities along the Caribbean coast. Together with the 60 sirens already in place since 2015, Nicaragua now has a total of 100 of these devices for tsunami warning and other emergencies. Thus, most of the population under tsunami danger can receive CATAC warnings by this means. The installation of sirens has also begun in the other Central American countries. CATAC has also worked on the development of other methods for sending

messages to the population through social networks, smartphone applications and direct communication between computers. An experimental phone application developed by CATAC allows the user located in a community on the Pacific coast to know the status of the tsunami warning and evacuation routes.

In addition, CATAC has established its website, which provides information on earthquakes and tsunamis for the target audience of CATAC products and for the general public. CATAC, in cooperation with Switzerland, also developed the Shakemaps website of strong earthquakes recorded by CATAC that shows the impact of earthquakes, which is important when assessing the situation of coastal populations after an event.

As CATAC can be temporarily affected by adverse circumstances and lose its ability to work partially or completely, a closer cooperation with MARN was developed with the objective of having it act as a backup for CATAC. In addition, CATAC with other seismological institutions in Central American and Spanish universities is preparing a new project to investigate seismic hazard and crustal structure in northern Central America. Particular studies were proposed that will have beneficial results in the medium term for tsunami warning (e.g. a regional model of seismic velocities, and improvement of the seismic monitoring of Honduras).

CATAC is preparing the use of GTS/GNSS in the process of seismological monitoring and characterization of large earthquakes. In 2021, Nicaragua established real-time transmission of high frequency data sampling from 25 GPS/GNSS stations to CATAC, retransmitted these data to UNAVCO and is working to implement software that allows the data to be used routinely.

Dr Strauch underlined that CATAC is working to ensure its sustainability and impact through several means, including creating documentation to facilitate integration of CATAC and the earthquake warning system in INETER´s institutional structure, to ensure sustainability according to the proposals of the joint project with JICA. It also ensures sustainability by promoting CATAC´s integration into the SICA system as a regional early warning agency, sharing through relevant Central American scientific institutions data in sufficient quality and quantity for the rapid processing of earthquakes and tsunamis from seismic, accelerographic, tide gauges and GNSS stations. CATAC also works towards sustainability by supporting scientific institutions relevant to seismology and tsunami in CA to increase their level of cooperation and integration to take optimal advantage of all capabilities. CATAC also will support civil protection agencies of the Central American countries to take advantage of new forms of alert dissemination to rapidly send alerts based on CATAC´s advisory to the population at risk. Joint seismology studies will also be conducted to improve seismic wave velocity and attenuation models within the frame of regional and international projects.

In closing, Dr Strauch recalled that ICG/PTWS-XXIX (December 2021) decided to admit the start of CATAC's full functionality on the interim service as of 17 January 2022 for the Pacific coast of Central America. He then requested that ICG/CARIBE-EWS also admit CATAC´s full operation for the Caribbean coast of Central America.

Mr Mike Angove commented that undersea criteria may not be necessary to include as governing criteria. He also enquired whether TOAST accounts for non-seismic sources. Mr Strauch responded that TOAST can automatically handle seismic sources, noting that TOAST can work on several systems in parallel; however, it is not capable of handling non-seismic sources. Finally, Mr Angove enquired what software will be implemented software that allow GTS/GNSS data to be used. Dr Strauch

responded that data processing will be conducted by a designated institution, although no further details are yet available. He added that preliminary tests would likely be conducted in end 2022; thus additional information will likely be shared during ICG/PTWS-XXX.

Dr Silvia Chacon enquired about CATAC threat levels, suggesting that these should be based on tsunami estimated time of arrival and not on distance, including to be aligned with practice across the CARIBE-EWS region. Dr Strauch responded that the CATAC threat levels are used for the first warning message, which is issued immediately and therefore prior to calculations of estimated times of arrival. Subsequent messages would be able to adapt to estimated times of arrival, but the first must be based on distance.

## *4 Task Teams Reports*

### *4.1 Task team Exercise CARIBE WAVE*

Dr Elisabeth Vanacore, Chair of TT CARIBE WAVE, reported on this item. The date of the CARIBE WAVE 2023 exercise was agreed to be 23 March 2023 at 1400 UTC.

In addition, potential scenarios were proposed and discussed. Two scenarios for Honduras were proposed: the first in the Gulf of Honduras and the second in Roatan. The former scenario was considered most favourable because it would generate a slightly larger event which would impact Belize. The Group also noted that all scenarios under consideration were for local tsunamis but agreed in conjunction with the Secretariat that this was acceptable. In addition, the Group noted that this provided an opportunity to further engage with Central America. Finally, the Group decided on the following two scenarios:

- **Scenario 1:** An earthquake generated tsunami of the northern coast of Honduras based on the Gulf_of_Honduras scenario in the CATSAM catalogue
- **Scenario 2:** A volcanic tsunami generated by an eruption on Mount Pelée – pending confirmation from local civil defense authorities in Martinique

The composition of the TT CARIBE WAVE 23 will follow the same structure of previous exercises with the addition of a representative for CATAC and an expert for each of the scenarios. Dr Vanacore encouraged the engagement of social scientists in national planning and the participation of people with disabilities. The timeline of the event will follow that used for previous exercises. She also recommended that Member States use Manual and Guides 86 (*Multi-annual community tsunami exercise programme: guidelines for the tsunami and other coastal hazards warning system for the Caribbean and Adjacent Regions*) and the corresponding WG4 trainings in preparation for the exercise.

Regarding the messaging for the Mount Pelée scenario, Mr Charles McCreery noted that PTWC and the TT on Tsunami Procedures for Volcanic Crises would need to consider what type of messaging to employ in the case of a volcanic-source tsunami.

Dr Vanacore also reported on the leadership and membership of the TT CARIBE WAVE. She noted that her term as Chairperson of the TT was already extended previously and enquired whether there should be a change of Chairperson in advance of CARIBE WAVE 2023. The Group agreed that she would serve another term, especially due to the short timeframe for planning CARIBE WAVE 2023.

### *4.2 Task team on Tsunami Ready Programme*

Mr Fabian Hinds, Co-Chair of the TT on Tsunami Ready Programme, reported on intersessional activities of the TT.

Due to impacts of the COVID-19 pandemic, the work of the TT in mid to late 2021 was impeded. He reported that preliminary work during this period included regular meetings of the co-Chairs, work on confirming the membership of the TT, and liaising with the IOC Secretariat and CTIC for support. During the intersessional period, the membership of the TT has been formalized with 10 members and three *ex officio* members confirmed. The TT held their first meeting on 18 May 2022, where members discussed and edited the Terms of Reference of the TT and the Feedback Survey on Implementation of the UNESCO/IOC Tsunami Ready pilot programme questionnaire. These documents will be subject to approval of ICG/CARIBE-EWS at its meeting in November 2022. Mr Hinds indicated that the next meeting of the TT would be held on 21 June 2022.

Finally, Mr Hinds recalled the recommendation mentioned during the Report of CTIC, indicating that CTIC is to play a role in identifying communities for potential implementation of Tsunami Ready. He noted that this task could also be integrated within the Terms of Reference of the TT and would be discussed at the upcoming meeting of the TT.

### *4.3 Task team on Tsunami Procedures for Volcanic Crises*

Dr Valerie Clouard, Chair of TT Tsunami Procedures for Volcanic Crises, reported on this agenda item. Dr Clouard began by providing an overview of the membership and leadership of the TT, noting the presence of the chairs of WG 1 through 4, the Chair of ICG/CARIBE/EWS, the Technical Secretary of ICG/CARIBE-EWS, the Director of PTWC, and two participants from volcano observatories in the region.

During the intersessional period, the TT on Tsunami Procedures for volcanic crises held two virtual meetings. In addition, two significant potentially tsunamigenic volcanic eruptions took place. The eruption of Cumbre Vieja on La Palma occurred from September to December 2021. Although there was speculation in the region of the Western Antilles about the threat of this eruption, no tsunami was generated in the CARIBE-EWS region. Dr Clouard noted that the TT drafted a document entitled “Information on recent Cumbre Vieja volcanic activity”; however, the document was not published. Dr Clouard reflected that this was likely due to a delay in drafting the document, thus reduced relevancy when it was ready, which is a lesson learned for the TT. The second significant volcanic eruption was the HTHH event in Tonga in January 2022 which generated a tsunami which was recorded in the CARIBE-EWS region.

Dr Clouard also reported that the TT is currently working on a document entitled “Responsibilities of the volcano observatory of St Vincent volcano for providing information related to tsunami threat relevant for the Caribbean Tsunami Service Providers”. This working document is derived from the Volcano Observatory Notice for Aviation (VONA) communiqué. The themes of the document are two-fold: to encourage volcano observatories to inform TSPs in the event of a potentially upcoming event and to improve tsunami messaging procedures in case of a tsunamigenic volcanic eruption. Finalising this document would provide an important step forward for establishing arrangements between volcano observatories and TSPs.

Finally, Dr Clouard noted that the CARIBE WAVE 2022 Exercise was intended to include a Cumbra Vieja scenario, which was removed due to the eruption of the volcano. She suggested this could provide a back-up volcano scenario for CARIBE WAVE 2023.

## *5 Working Group Progress Reports*

### *5.1 Working Group 1: Monitoring and detection systems*

Dr McNamara began by recalling the Terms of Reference and membership of WG1, highlighting key updates. He next provided an update on the status of the CARIBE-EWS seismic network, noting that 37 new real-time seismic stations had been added. However, major seismic stations outages have been ongoing throughout 2021 and 2022, with 32 stations with the status down. Specifically, significant problems with data have occurred in Honduras, Nicaragua, Costa Rica, and Panama. There are continued gaps in Haiti, Venezuela, and Trinidad and Tobago. Regarding the seismic network, Dr McNamara recommended that WG1 conduct a survey to determine consistency of station list and meta-data across tsunami warning centre (TWCs), IRIS and USGS; consider use of Raspberry Shakes by TWCs to fill in gaps; and support the use of sea-flood cable instrumentation. He added that Raspberry Shakes were used by the USGS to locate the 2021 Mw=7.2 Haiti earthquake, suggesting that IRIS explores the availability of data and that WG1 explores the cost of direct real-time feeds to NOAA. In addition, WG1 is exploring the use of sea-floor cable instrumentation in monitoring and detection of tsunamis and has invited Matt Fouch to discuss SMART repeater technology at ICG/CARIBE-EWS-XVI.

Dr McNamara next reported on the status of the sea-level network, highlighting new stations that were installed in 2022 in Chateau Belair (St. Vincent), Cayman, and Puerto Rico. However, significant station outages are ongoing in the region, especially on the Caribbean coast of Central America as well as in Haiti, Jamaica, St Martin and Barbados. In addition, all NOAA DART gauges are currently not operational. The ITIC-CAR produced an annual report in December 2021 which reported six stations down with two others having unknown status. In addition to relevant recommendations from ICG-CARIBE-EWS, Dr McNamara suggested that based on these ongoing shortages, WG1 should also support the use of the NOC maintenance manual for NOC tide gauge operators.

Dr McNamara provided an update on the status of GNSS in the Caribbean. As of 8 June 2022, the NOTA GNSS network is at 90 percent operating level across the globe. He also indicated that USGS NEIC recently used GNSS in real-time for finite fault models. Dr McNamara recommended that UNAVCO NOTA staff visit NOAA TWCs to evaluate the status of GNSS integration and noted that Tim Melbourne had been invited to discuss GNSS integration at ICG/CARIBE-XVI in November 2022.

Dr Liz Vanacore enquired how often the metadata of the seismic network is updated, noting that a few stations were missing or outdated. Ms Christa von Hillebrandt-Andrade noted that new sea level stations exist in Haiti. Dr McNamara responded that metadata is usually updating daily at IRIS and at USGS. Dr Chip McCreery noted that for tsunami centres there is no specific timing, although Dr Stuart Weinstein regularly updates the metadata for PTWC.

Dr Wilfried Strauch commented that Central America has many seismic stations, and ICG/CARIBE-EWS should apply more pressure to countries to share their data, noting that most countries are open to this. He specifically suggested drafting an official letter addressed to relevant

officials in each country. The Chair, Dr Silvia Chacon, agreed that she would speak with relevant experts within UNA in Costa Rica.

Mr Fabian Hinds commented that payment was received for two new sea level stations which they hope to have updated and operational as soon as possible.

### *5.2 Working Group 2: Hazard assessment*

Mr Nic Arcos reported on the activities of WG2, beginning with a brief overview of the WG2 Fact Sheet, membership, and Terms of Reference. During the past intersessional period, Mr Arcos reported that WG2 held one virtual meeting in December 2021 which had six participants and that members have further discussed key topics through email threads.

Regarding the recommendation ICG/CARIBE-EWS-XVI to provide access to and/or compile non-seismic sources, WG2 has added to CATSAM a published a scenario on the Kick'em Jenny landslide (from Harbitz et al., 2012, Continental Shelf Research). Discussions also took place with TT on volcano procedures regarding volcanic-source tsunamis, but WG2 concluded that most of the scenarios of non-seismic tsunamis in the Experts Meeting on Sources of Tsunamis in the Lesser Antilles (2019) Workshop (Report No. 291) are either *not published or even not simulated yet*. Mr Arcos identified several possible ways forward including that the propositions of scenarios be added to CATSAM be evaluated by experts from WG2, that WG2 work in collaboration with the new ICG/PTWS *ad hoc* team on volcanic-source tsunamis, and that a WG2 meeting on this subject be held in August or September 2022.

Mr Arcos next reported on CATSAM updates, noting that about 35 scenarios and their associated fault planes and sources from the Lesser Antilles Experts Meeting have been added to CATSAM, as well as the above-mentioned landslide of the Kick'em Jenny volcano landslide scenario. Mr Arcos expressed appreciation to the EDANYA Group (Universidad de Málaga) and to GTM-NGI (Global Tsunami Model - Norwegian Geotechnical Institute), specifically Dr. Harbitz, for making the Kick'em Jenny scenario available. In addition, the CARIBE WAVE 22 scenario is due to be added to CATSAM in the upcoming months. WG2 also worked on addressing bugs in CATSAM and updating the CATSAM URL (https://www.ncei.noaa.gov/maps/CATSAM/).

WG2 has also developed a guide on uploading elevation data to the Caribbean Marine Atlas and has encouraged Member States to upload their data, and at minimum upload details on the available data (e.g., extent, resolution, where to obtain, etc.). This process will help to identify data that is available. Mr Arcos highlighted that the key question for the WG to address now is where to proceed from here. He recalled that in most cases, a digital elevation model (DEM) would be created based on this data, which would then provide the basis for hazard assessments. The challenge with DEMs is maintain their relevancy, as they can rapidly become outdated. Recalling a proposal made by WG2 several years ago, Mr Arcos suggested that a workshop be held on building DEMs through a low-cost approach using open-source technologies. DEM workshop(s) would also be a long-term solution allowing for local or regional entities to create and update the DEMS as needed, as well as potentially allowing more funds to be spent on data collection.

With regards to the recommendation to understand the current state of evacuation mapping and planning processes, WG2 recognized that another survey to evaluate this could burden Member States, considering the number of existing surveys. An alternative proposal is to edit and amend the

National Report to include questions on evacuation mapping and signage, so that these themes are addressed on a systematic and annual basis. During this process, WG4 also indicated the overlap between these questions and questions featured in the CARIBE WAVE questionnaire, again reflecting an ongoing concern of duplication. Because the National Reports and Caribe WAVE questionnaires are sometimes not answered by the same national agency, WG2 suggests making updates to both documents. This would also allow for a wider discussion on the best method to approach any future updates.

Dr Elizabeth Vanacore enquired whether national reports overlap with Key Performance Indicators (KPIs). Dr Mary Rengifo, Co-Chair of the TT KPIs addressed this topic in agenda item 6.1.

### *5.3 Working Group 3: Tsunami Related Services*

Mr Emilio Talavera reported on the report intersessional activities of WG3, starting by recalling the purpose, function, and membership of the WG as defined in its Terms of References.

Mr Talavera indicated that WG3 activities have been severely affected by the COVID-19 pandemic. The ability of WG3 to engage in information dissemination has been compromised due to problems with dissemination systems which have reduced their information transmission capacity. He noted that WG3 has focused on dissemination of information and warnings through e-mail messaging services and the internet. In addition, WG3 has focused on conducting communications test given that community evacuation drills were not feasible. Mr Talavera presented on the communications methods used by Member States during CARIBE WAVE 22, highlighting a trend towards reliance on the internet and emails. Echoing recommendations of previous ICGs, Mr Talavera strongly suggested that countries continue to diversity their means of receiving communications and move away from reliance on a single method, making specific reference to voluntary amateur radios. Mr Talavera also recalled other key recommendations from ICG/CARIBE-EWS.

Regarding the next intersessional period, Mr Talavera recommended that initiatives regarding applications of new technology applications such as web 2.0 or others be resumed to facilitate the dissemination of information in case of tsunami emergencies and that Member States update their memberships in WG3.

In closing, Mr Talavera noted that, given continued challenges with COVID-19, the workplan for WG3 should be established for the next intersessional period to be agreed upon at ICG/CARIBE-EWS-XVI in November 2022.

Ms Christa von Hillebrandt-Andrade commented that past caribe wave exercises have included an overview and training on GeoNetCast information systems and the WMO WIS; however, this has not led to changes in use of these technologies thus far. Ms von Hillebrandt-Andrade also noted that there has been an increasing use of amateur radios according to registrations made in the tsunamizone.org website.

Dr Liz Vanacore suggested a more in-depth analysis of the CARIBE WAVE exercise be conducted to better determine the methods used and analyze ways to proceed. In addition, she suggested that WG3 could benefit from a social scientist to examine communications methods.

Dr Valerie Clouard enquired whether Caribe wave messages were issued using GeoNetCast Americas. Ms Christa von Hillebrandt-Andrade responded that the messages were sent over GTS and could be accessed by GeoNetCast Americas in countries/TWFP that had these systems. In addition, she noted that Eliot Christian will present on CAP at ICG/CARBE-EWS-XVI in November 2022.

### *5.4 Working Group 4: Preparedness, readiness and resilience*

Ms Christa von Hillebrandt-Andrade reported on WG4, beginning by recalling the membership, purpose and functions of the WG. Regarding the Terms of Reference, she suggested the addition of "response" to be considered at ICG/CARIBE-EWS-XVI in November 2022. She also encouraged a more active participation of WG4 members. She also drew attention to the name change of the Caribbean Tsunami Warning Program (CTWP) to ITIC-CAR, noting that no changes in duties, staffing, or staffing have occurred.

Ms Christa von Hillebrandt-Andrade recalled the COVID-19 Guidelines developed by WG4 and the related video produced by UNDRR. In addition, Manuals and Guides 86, *Multi-annual community tsunami exercise programme: guidelines for the tsunami and other coastal hazards warning system for the Caribbean and Adjacent Regions* was finalized and published. This was an initiative originally started by France and then finalized with support from the Universidad Nacional Costa Rica, WG4, the IOC Secretariat and ITIC-CAR. The manual is currently available in English and French, with the Spanish version in final stages. A designated (unofficial) TT has been established to set out a strategy for implementation of this approach, including a training for Members States. Another suggestion has been to link the training or other relevant activities to the CARIBE WAVE Exercise.

WG4 is also in the process of updating the CARIBE-EWS Tsunami Signage Inventory and Report, with expected finalization in June 2022. Ms von Hillebrandt-Andrade noted that a draft version of the document is already available online (on the meeting website of WG4), with next steps for finalization including circulation to Member States for additional feedback. She proposed posting of the document on the CTIC and/or ITIC websites.

Ms von Hillebrandt-Andrade recalled that part of the mandate of WG4 is to support World Tsunami Awareness Day (WTAD), and thus engage with UNDRR and CTIC on relevant activities. In the context of WTAD 2021, two videos were produced showcasing St. Kitts and Nevis and Caribbean donors and partnerships. WTAD 2022 will focus on target (g) of the SFDRR: "access to multi-hazard early warning systems and disaster risk information and assessments". In celebration of the day, several videos will again be produced. Ms von Hillebrandt-Andrade noted the need for high quality video footage from Member States (about 15 to 20 seconds). In addition, Creative Risk Communications has reached out for other filming projects in the Caribbean; a meeting is planned between WG4 Officers and CTIC on this topic.

In the context of the UN Ocean Decade and the ODTP, CTIC and WG4 participated in IOCARIBE Safe Ocean WG meetings and events as well as in the Global Safe Ocean Laboratory. A project was submitted to the UN Ocean Science decade on "Integrating Coastal Hazards Early Warning Systems and Services in the Tropical Americas and Caribbean" (iCHEWS). It has been recommended for endorsement under the Decade Programme Coast Predict. UNESCO/IOC made an official announcement on 8 June 2022 on the new endorsed projects.

Regarding the recommendation for WG4 to prioritize integration of social science into actions and activities, Ms von Hillebrandt-Andrade reported that the article database on the Social dimension of disaster risk reduction in the Caribbean and adjacent regions (originally compiled by Anna Grimes in 2020) is regularly updated, with the most recent updates in February 2022. In addition, WG4 has encouraged the participation of social scientists in CARIBE WAVE Exercises. In CARIBE WAVE 2021, 11 Member States and Territories engaged social scientists in the exercise. WG4 is also exploring opportunities to conduct a perception study of tsunami and other coastal hazards risks and early warning systems in the CARIBE-EWS.

The online order form for CTIC and ITIC educational and outreach materials hosted by ITIC-CAR had to be discontinued due to IT security concerns; thus, ITIC has prepared a fillable PDF order form instead. ITIC-CAR will coordinate with CTIC on this as there have been some issues with customs clearance. In addition, ITIC informed WG4 that the OTGA modules on Tsunami Awareness and Tsunami Ready are in advanced stages and should be available for remote and hybrid delivery within 2022.

The ICG/CARIBE-EWS-XV recommended the TT Evacuation Maps, with support from WG2, WG4 and CTIC, to create a repository at the regional level to hold all national evacuation maps at the regional level to hold all national evacuation maps and "How to" manuals and supplemental manuals used for the creation of the tsunami inundation and evacuation maps. Currently, the ITIC Tsunami Ready website (tsunamiready.org) has the maps of all communities that have been recognized as Tsunami Ready by UNESCO/IOC; in the case of Puerto Rico and the US Virgin Islands, these maps are on the Puerto Rico Seismic Network (PRSN) website. At the moment, there is no space to share maps for communities that are not recognized Tsunami Ready. Regarding documents and manuals for tsunami evacuation and inundation manuals, they are posted on the ITIC website. WG4 will follow-up on these topics with the TT Evacuation Maps and WG2.

In closing, Ms von Hillebrandt-Andrade outlined some of the key considerations, challenges, and opportunities of the past inter-sessional period for WG4. Key challenges included COVID-19, other hazards and disasters and all related cascading effects on human and financial resources, especially for disaster risk managements offices; limited financial resources to implement actions; limited engagement of members in WG activities; and lack of availability of ITIC education and outreach materials in languages other than Spanish and English. Opportunities to be maximized include those provided by CARIBE WAVE, WTAD and Tsunami Ready to advance tsunami preparedness, readiness and resilience. In addition, Multiannual Exercise Guidelines and Tsunami Ready Guidelines have been finalized to support advancement of tsunami preparedness, readiness, response and resilience.

Dr Elizabeth Vanacore commented that WG4 could set out how to conduct post-hurricane signage surveys. Ms von Hillebrandt-Andrade agreed that signage needs to be routinely reviewed, especially after hurricanes, noting that signage inventories are a means to identify any damaged signs.

## *6 Policy matters*

### *6.1 Future goals and key performance indicators*

Dr Mary Rengifo reported on this agenda item. She recalled that this TT is composed of members from each of the UNESCO/IOC ocean regions: NEAMTWS, IOTWMS, PTWS, and CARIBE-EWS.

The global framework aligns with key frameworks including the SFDRR, the UN Ocean Decade (specifically “A Safe Ocean”), the IOC Tsunami Programme, and Tsunami Ready.

The five goals identified by the TT are as follows: understanding and managing tsunami hazard and risk; tsunami detection, warning and dissemination; enhancing tsunami preparedness for effective community response; tsunami event response and recovery; and global ocean coordination, cooperation and partnerships. Each goal has several associated objectives, and each of these are measured through an achieved percentage (four ranks: 0%-25%; 25%-50%; 50%-75%; 75%-100%). The expectations are to monitor and evaluate against this framework; provide yearly reports via the annual ICG meeting structures; align all activities with the UN Ocean Decade; and participate in annual TOWS meetings on global basin assessments, notably detailing gaps, opportunities and improvements in regard to their evaluation against the framework.

The global framework will be accessible through a web-based portal hosted on the IOC website. It will use algorithm functionality, have real-time graphs, be fair and ethical, and be easy, accessible and simple for national, ICG and global reporting.

Ms Rengifo next recalled recommendations made by TOWS-WG TT-DMP as well as the current membership of the TT. She also noted that the Terms of Reference of the TT Future Goals and key Performance Indicators had been updated to include presentation of a report and status of the implementation plan (2018-2023 at ICG/CARIBE-EWS-XVI; presentation of a progress report on the development of global performance indicators for tsunami warning systems at ICG/CARIBE-EWS-XVI; and carrying out of annual monitoring of the global KPI progress measurement by the TT. Ms Rengifo also reported that the TT is currently reviewing the progress status of the implementation plan, by measuring objectives against achievements using the indicators.

Ms Christa von Hillebrandt-Andrade enquired about harmonization between survey efforts at the global, regional, and national level, including related to effective allocation of resources. She noted that several WGs and TTs have suggested conducting surveys and that alignment and harmonization would be useful to avoid overloading Member States with work and considering resource limitations. Ms Rengifo agreed that alignment on this level is essential, and that the TT is currently working on this, including by bringing the surveys into an online system. However, this is still a working progress and may not be finalized by in time for the next ICG/CARIBE-EWS meeting.

### *6.2 UN Decade of ocean science for sustainable development and decade tsunami programme*

Mr Mike Angove reported on this agenda item. He began by underlining the importance of tsunami within the UN Ocean Decade, considering that at-risk populations need tsunami alerts that are timely, relevant and accurate. Consistently delivering alerts with these attributes is a significant challenge for the Global Tsunami Warning System, given reliance on high-uncertainty proxy relationships. This challenge is greatly amplified when considering tsunamis generated without seismic cues, as this requires a fundamentally different approach to solving the problem. Indeed, in this case, first indicators often come too late to take evasive action, observing systems are not tuned to support forecasts for non-seismic sources even when early detections are made, and warning centres are not all conditioned to anticipate or respond to non-seismic source tsunamis. However, by shifting focus toward direct tsunami detection and measurement (i.e. *in situ*, real-time data), timeliness, relevance and accuracy of all tsunami alerts can be improved.

Tsunamigenic processes—even those associated with earthquakes—are complex and difficult to accurately simulate in real-time. In contrast the tsunami wavefield is detectable and measurable—with the right instruments and techniques—and propagates deterministically in open water. Focusing effort on improving direct tsunami detection and measurement will allow that Global Tsunami Warning System to address all tsunamis independent of source, and this will support decisions informed by accuracy and precision, rather than broad uncertainties.

In addition, Mr Angove highlighted that improved alerting supports the main societal outcome of the ODTP: to make 100 percent of communities at risk of tsunami prepared for and resilient to tsunamis by 2030.

Mr Angove next reported on the Scientific Committee for the ODTP (SC-ODTP), drawing attention to the membership and upcoming Second Meeting of the SC-ODTP to be held 21-23 June 2022. He highlighted that a key element of the agenda for this meeting will be to continue developing a strong strategic framework which engages all ICGs and covers key thematic areas.

Finally, Mr Angove reiterated that the UN Ocean Decade provides the opportunity to rethink ocean observations and thereby reduce uncertainty in global tsunami forecasts. This includes, for instance, moving beyond traditional seismic capabilities to also include ocean bottom cables, ocean bottom seismometers, infrasound, and other areas.

### *6.3 Background on ICG/CARIBE-EWS Service Model*

Ms Christa von Hillebrandt-Andrade reported on this agenda item, recalling the ICG/CARIBE-EWS service model and setting out the process for endorsement of CATAC.

In December 2015, ICG/CARIBE-EWS-X approved an ICG/CARIBE-EWS service model (see *Figure 1* below) which was developed by the TT Tsunami Service. This model was a people/community at-risk centered service model. This model proposed for CARIBE-EWS to have regional tsunami service providers. Although originally, these regional providers were intended to service all Member States, it was quickly realized that there could be space for sub-regional efforts addressing specific needs for a sub-set of countries.

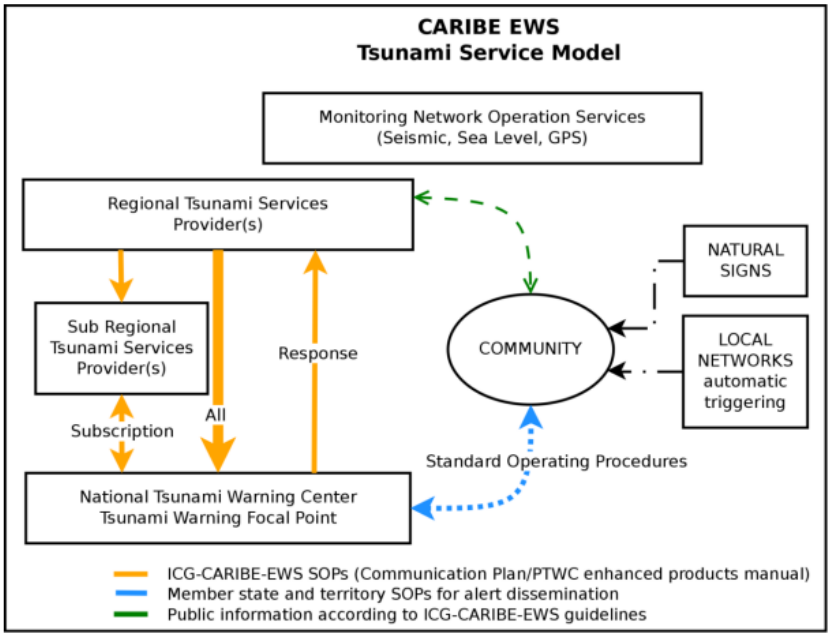



*Figure 1. CARIBE-EWS Tsunami Service Model*

The TOWS-WG-VIII (2015) adopted the definition of a tsunami service provider as a "centre that monitors seismic and sea level activity and issues timely tsunami threat information within an ICG framework to [NTWCs]/[TWFPs] and other TSPs operating within an ocean basin." Subsequently, the ICG/CARIBE-EWS-X (2015) adopted the Tsunami Service Model with TSPs and subregional TSPs. The distinction between TSP and subregional TSP is that the TSP provides services to all member states and subregional TSP's send products only to Member States and Territories that have subscribed to their services. At this time, the TT Tsunami Service was charged with developing the TSP requirements which were to consider the following: Tsunami Service Model (draft from December 2014), discussions at ICG/CARIBE-EWS-X, relevant recommendations from TOWS-WG, and the work and documentation provided for other Tsunami Warning Systems (PTWS, IOTWMS, and NEAMTWS). During this meeting, the ICG also accepted Nicaragua's offer to host and develop the CATAC as a sub-regional TSP under the guidance of the PTWS Regional Working Group for Central America Pacific Coast and within the framework of ICG/PTWS, ICG/CARIBE-EWS and TOWS-WG.

The ICG/CARIBE-EWS-XI (2016) then approved the *Technical, logistical and administrative requirements of a regional TSP for the CARIBE-EWS* including the proposed key performance indicators and goals. This document includes key performance indicators to be fulfilled by any regional TSP. The ICG also decided that the PTWC be henceforth referred to as a CARIBE-EWS regional TSP, removing the term "interim".

The Chair, Dr Silvia Chacon, clarified that this agenda item was purely informative, and that the decision to endorse CATAC as a regional TSP must be taken at an ICG meeting and would thus be discussed again at ICG/CARIBE-EWS-XVI in November 2022.

## *7 Next session*

### *7.1 Confirmation of date and place of ICG/CARIBE EWS-XVI*

Dr Mark Oduber (Aruba/UNESCO), reported on this agenda item, providing an overview of the upcoming ICG/CARIBE-EWS-XVI which will be held in Aruba from 22-26 November 2022. The Host Country Agreement with UNESCO is currently under negotiation and thus pending finalization. The meeting will be held at the Hyatt Place Aruba Airport and Aruba Emergency Management Office and will be in hybrid format. He provided information on travel to Aruba, logistics, and weather. He also highlighted that Aruba hopes to capitalize on the hosting of the meeting in order contribute to tsunami awareness in Aruba and support further development of tsunami warning.

The Chair, Ms Silvia Chacon, enquired about COVID-19 requirements in Aruba. Dr Oduber noted that requirements will likely evolve by November 2022 and that further information would be provided in due course, including through the "COVID-19" section of the Host Country Agreement.

Mr Mike Angove enquired about the possibility of changing dates of the meeting due to overlap with Thanksgiving holidays in the United States, noting that Mr Bernardo Aliaga, Technical Secretary of ICG/CARIBE-EWS had been previously engaged on this issue. Dr Oduber responded that dates will be complicated to move due to the agenda of the Emergency Management Office. Mr Angove and Dr Chacon noted that they would continue discussions on this with the IOC/TSU Secretariat.

## *8 Any other business*

Ms Christa von Hillebrandt-Andrade recommended that ICG/CARIBE-EWS support revamping of the TT Other Coastal Hazards, considering that its themes are relevant to current ICG activities but that the TT currently does not have a Chair nor membership. The Chair, Dr Silvia Chacon, suggested that this topic be discussed at ICG/CARIBE-EWS-XVI (November 2022).

The Chair, Dr Silvia Chacon, reminded the Group that elections will be held during ICG/CARIBEW-EWS-XVI in November 2022 and that she will not be renewing her position as Chair.

## *9 Close of the session*

The session was closed at 16:00 (UTC) on Thursday 9 June 2022.

## Annex 1. List of participants

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## Annex 2. List of Acronyms

| | |
|---|---|
| **AusAid** | Australian Aid |
| **CATAC** | Central American Tsunami Advisory Centre |
| **CDEMA** | Caribbean Disaster Emergency Management Agency |
| **CEPREDENAC** | Coordination Centre for the Prevention of Natural Disasters in Central America |
| **COPECO** | Honduras Comisión Permanente de Emergencias |
| **CTIC** | Caribbean Tsunami Information Center |
| **DART** | Deep-ocean Assessment and Reporting of Tsunami |
| **DRR** | disaster risk reduction |
| **DEM** | digital elevation model |
| **ESZ** | earthquake source zone |
| **EWARNICA** | Early Warning in Nicaragua and Central America |
| **GNSS** | Global Navigation Satellite System |
| **GPDRR** | Global Platform for Disaster Risk Reduction |
| **GTS** | Global Telecommunication System |
| **ICG** | Intergovernmental Coordination Group |
| **ICG/CARIBE-EWS** | Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions |
| **ICG/IOTWS** | Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System |
| **ICG/NEAMTWS** | Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-Eastern Atlantic, the Mediterranean and Connected Seas |
| **ICG/PTWS** | Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System |
| **iCHEWS** | Integrating Coastal Hazards Early Warning Systems and Services in the Tropical Americas and Caribbean |
| **IGC-UPA** | Panama Institute of Geosciences of the University of Panama |
| **INITER** | Instituto Nicaraguense de Estudios Territoriales (Nicaragua) |
| **INSIVUMEH** | Sismología, Vulcanología, Meteorología e Hidrología de Guatemala |
| **IOC** | Intergovernmental Oceanographic Commission (of UNESCO) |

| | |
|---|---|
| **IODE** | International Oceanographic Data and Information Exchange |
| **IRIS** | Incorporated Research Institutions for Seismology |
| **ITIC-CAR** | International Tsunami Information Center Caribbean Office |
| **JICA** | Japan International Cooperation Agency |
| **KPI** | Key Performance Indicator |
| **HTHH** | Hunga Tonga Hunga Ha`apai |
| **MARN** | Ministry of Environment and Natural Resources (El Salvador) |
| **MHEWS** | multi-hazard early warning system |
| **MHEWS-III** | Third Multi-Hazard Early Warning System (MHEWS-III) Conference |
| **NORAD** | Norwegian Agency for Development Cooperation |
| **NTWC** | national tsunami warning centres |
| **ODTP** | Ocean Decade Tsunami Programme |
| **OTGA** | Ocean Teacher Global Academy |
| **OVSICORI** | Observatorio Vulcanológico y Sismológico de Costa Rica |
| **PRSN** | Puerto Rico Seismic Network |
| **PTWC** | Pacific Tsunami Warning Centre |
| **PTWS** | Pacific Tsunami Warning and Mitigation System |
| **REWSC** | Regional Early Warning System Consortium |
| **SC-ODTP** | Scientific Committee for the Ocean Decade Tsunami Programme |
| **SFDRR** | Sendai Framework for Disaster Risk Reduction |
| **SINAMOT** | Sistema Nacional de Monitoreo de Tsunamis (Costa Rica) |
| **SOPs** | Standard Operating Procedures |
| **SRC** | Seismic Research Centre (of the University of the West Indies) |
| **TIC** | Tsunami Information Centre |
| **TOWS-WG** | Working Group on Tsunamis and Other Hazards |
| **TRRP** | Tsunami Ready Recognition Programme |
| **TSP** | Tsunami Service Provider |
| **TT** | Task Team |
| **TT DMP** | TOWS-WG Task Team on Disaster Management and Preparedness |
| **TWC** | tsunami warning centre |
| **TWFP** | Tsunami Warning Focal Point |
| **UCR** | Universidad de Costa Rica |

| | |
|---|---|
| **UNA** | Universidad Nacional Costa Rica |
| **UNAH** | Universidad Nacional Autónoma de Honduras |
| **UNAVCO** | NAVCO, Inc. (independent, non-profit, corporation) |
| **UNDRR** | United Nations Office for Disaster Risk Reduction |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **USAID** | United States Agency for International Development |
| **USGS** | United States Geological Survey |
| **VONA** | Volcano Observatory Notice for Aviation |
| **WG** | Working Group |
| **WTAD** | World Tsunami Awareness Day |